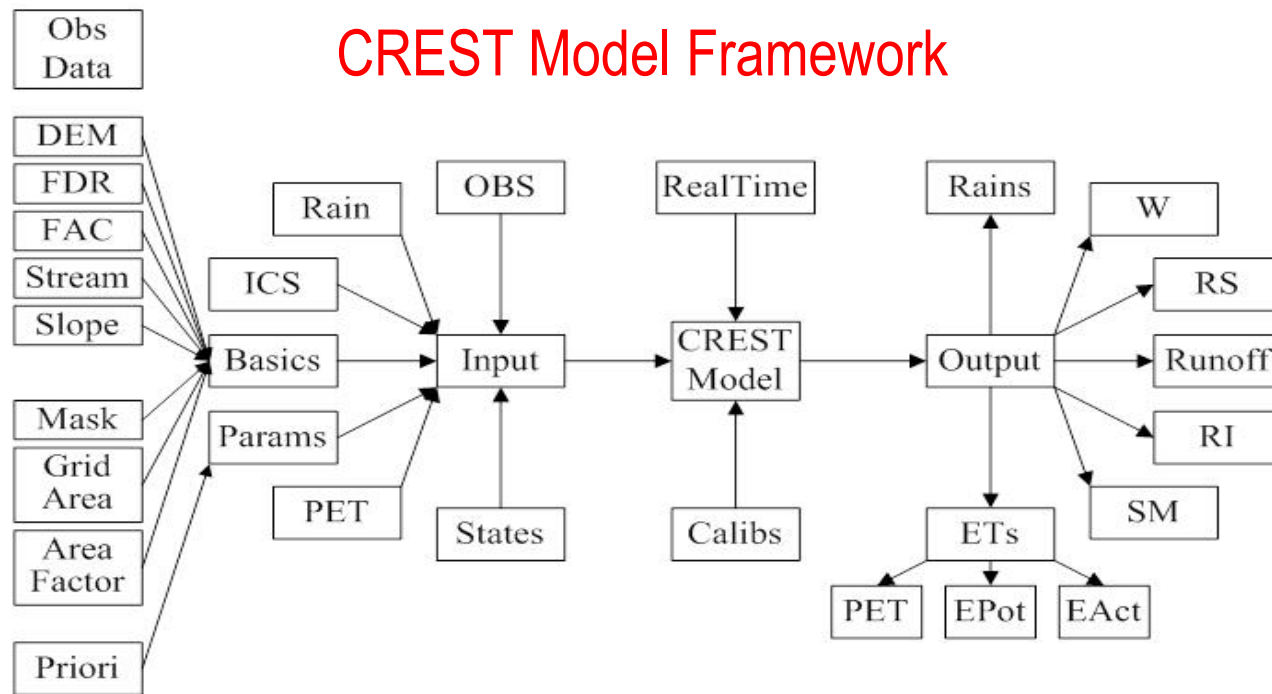


***CREST model for Tunisia:  
Model Description, Calibration , Evaluation and Sensitivities***

***Kunhikrishnan Thengumthara  
May, 2014  
Updated by F. Policelli 7/17/14***

- ❑ Coupled routing and excess storage (CREST) model,
- ❑ Version 2.0 . (Wang et al., 2012)



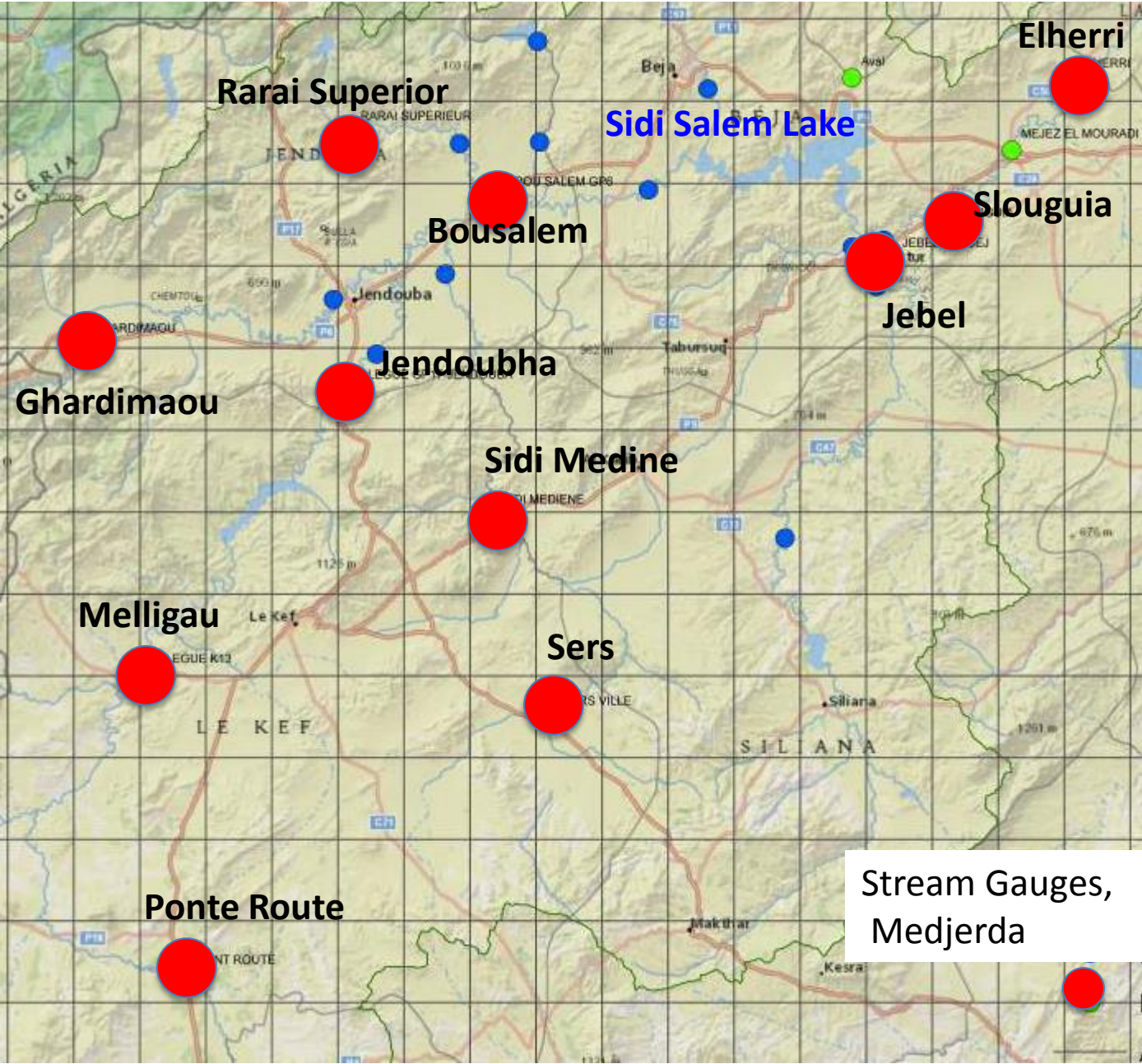
- Hybrid Model Strategy (Physical and Statistical)
- Model components: Rainfall-Runoff processes, ET, sub-grid routing, downstream routing
- Simulates spatial and temporal variations of water fluxes and storage on a grid.

## ❑ Driving Data:

- **TMPA-RT V7: TRMM Multi-Satellites Precipitation Analysis**  
Grid: 0.25°, 3-hour, Latency: 6-8 hours, Coverage: 50°N-S  
(Huffman G et al., 2007)
- **Potential Evapotranspiration (PET):**  
Famine Early Warning Systems Network (FEWS) ET Climatology (~ 0.25°),  
(<http://igskmncnwb015.cr.usgs.gov/Global/>) .  
ALEXI-ET: Atmosphere-Land Exchange Inverse model  
[Anderson et al., 2012]  
MODIS-ET (Mu et. al., 2012)

## ❑ Input Basics

- **SRTM-DEM: Shuttle Radar Topography Mission, (~1km, ~90m),**  
Hydrologically corrected, coverage: 60°N-56°S
- ❑ **Initial conditions :** Soil moisture, overland/interflow
- ❑ **Physics Parameters:** Soil hydraulic conductivity and water capacity,  
multipliers for Rain, ET, runoff velocity coefficient and exponent for  
Infiltration curve



*Rough Sketch of Station Locations (not scaled) map: Extracted from the original Gauge /RW map of Tunisia prepared by Katherine Melocik*

# CREST Model Calibration-Tunisia (1 km resolution)

Basin	Spatial Res.	Temporal Res. Of Streamflow Obs.	Calibration Time Step	Calibration NSCE	Calibration Bias (%)	Calibration CC	Calibration period - start time	Calibration period - warm up time	Calibration period - end time
Jendouba	1km	1hr	3 hr***	0.113409	-50.643287	0.384311	2007060100	2008010100	2009123100
Slouguia	1km	daily avg.	daily**	0.172266	-22.289784	0.463737	2006060100	2007010100	2007123100
Rarai Superieur	1km	daily avg.	daily**	0.446257	0.486028	0.6682	2007010100	2007010100	2007123100
Jebel Laouej	1km	daily avg.	daily**	0.493647	-6.261947	0.706892	2007010100	2007010100	2007123100
El Herri	1km	daily avg.	daily**	0.275675	-7.642192	0.532392	2007010100	2007010100	2007123100
Bou Salem	1km	1hr	3 hr***	0.164597	21.101705	0.446484	2008010100	2008060100	2009123100
Mellegue	1km	daily avg.	daily**	0.223044	-51.005334	0.496335	2007010100	2007010100	2007123100
Ghardimaou	1km	1hr	3 hr***	0.047367	-56.457916	0.242016	2008010100	2008060100	2009123100

\*\*Results from model 3 hour time steps are averaged over 24 hours  
 \*\*\*Using observations from times coincident with model time steps (i.e. 1/3 of the observed data is used)  
 Note: This assumes that the streamflow data is an instantaneous reading, not an average

**Precipitation:** TMPA-RT V7R2 (3 hours)  
**ET:** FEWSNET 0.25 degree monthly climatology  
**DEM:** 1km resolution, resampled from 90m Hydrosheds DEM

## Stream Gauge Calibration Data

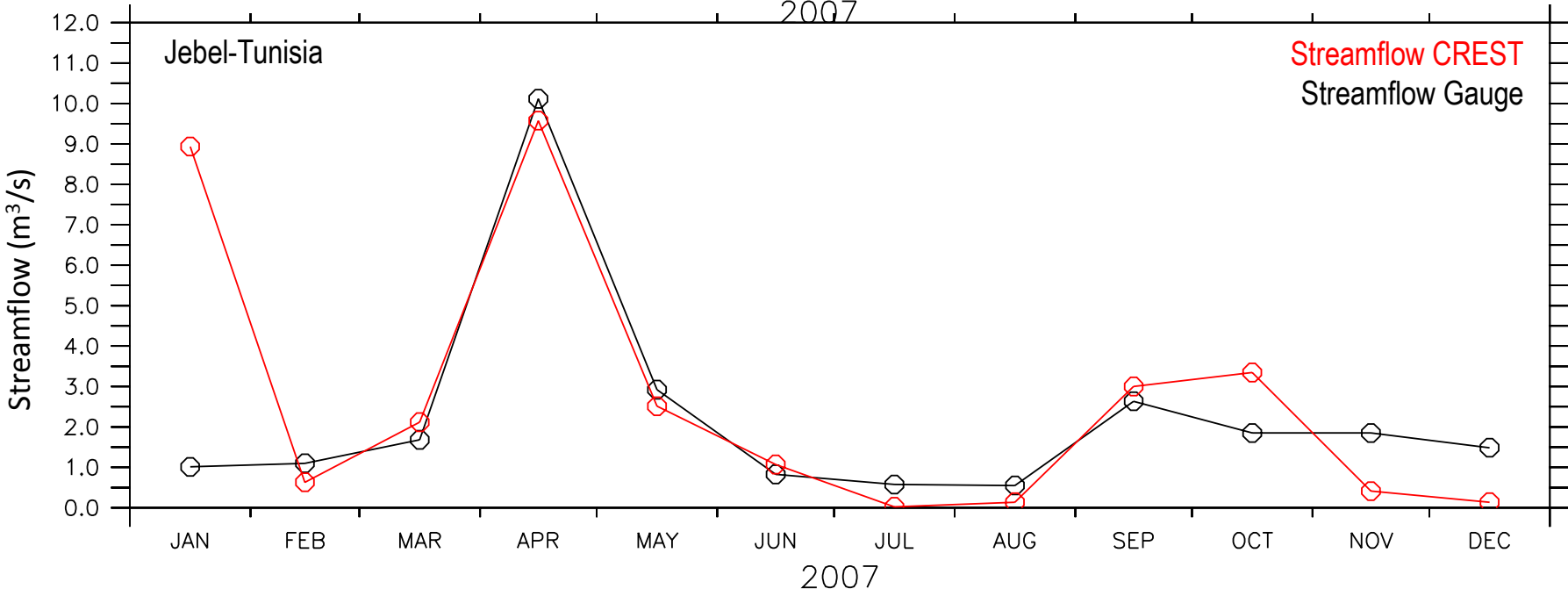
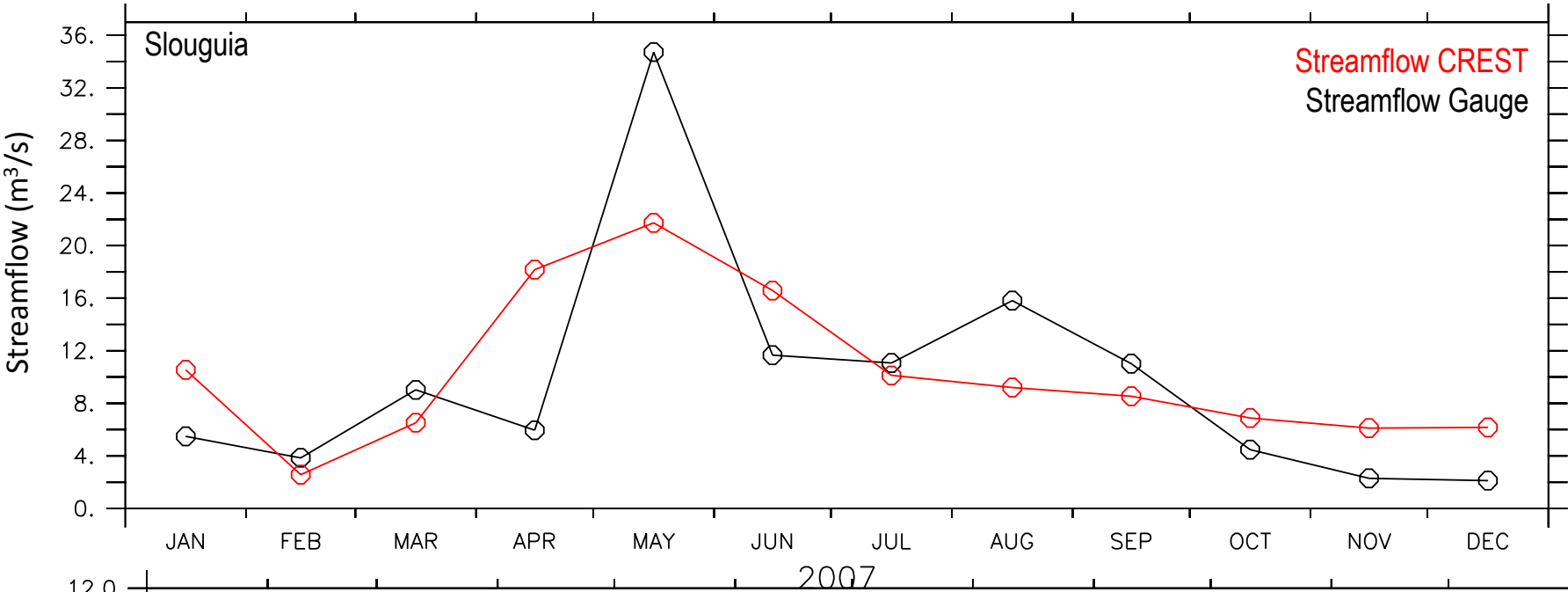
- Data provided by Tunisia, Email from Sinan Bacha to Fritz Policelli dated 07/18/2013

## Flood Model

- RECREST\_VERSION 229
- RECREST\_REV\_DATE="Mon Jan 13 06:45:40 2014 -0600"
- Model time step: 3hours for all stations

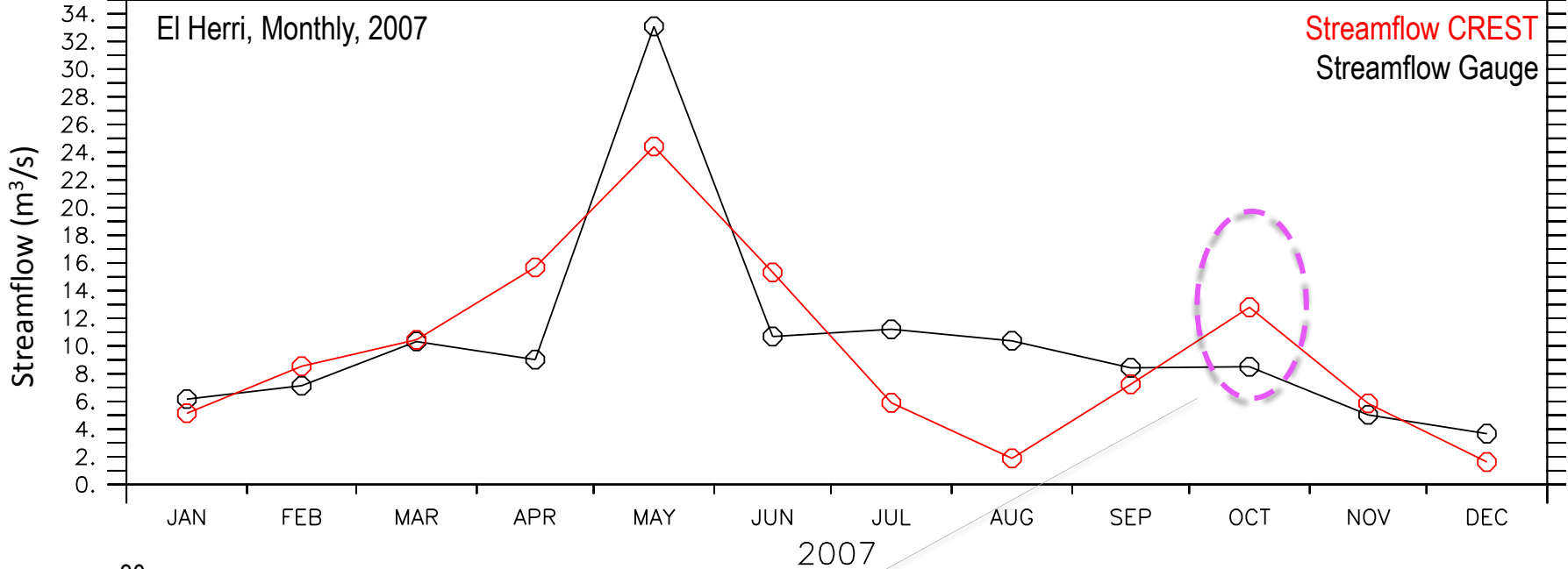
[After John David (EBo)]

CREST Calibration (1km) versus Stream-Gauge

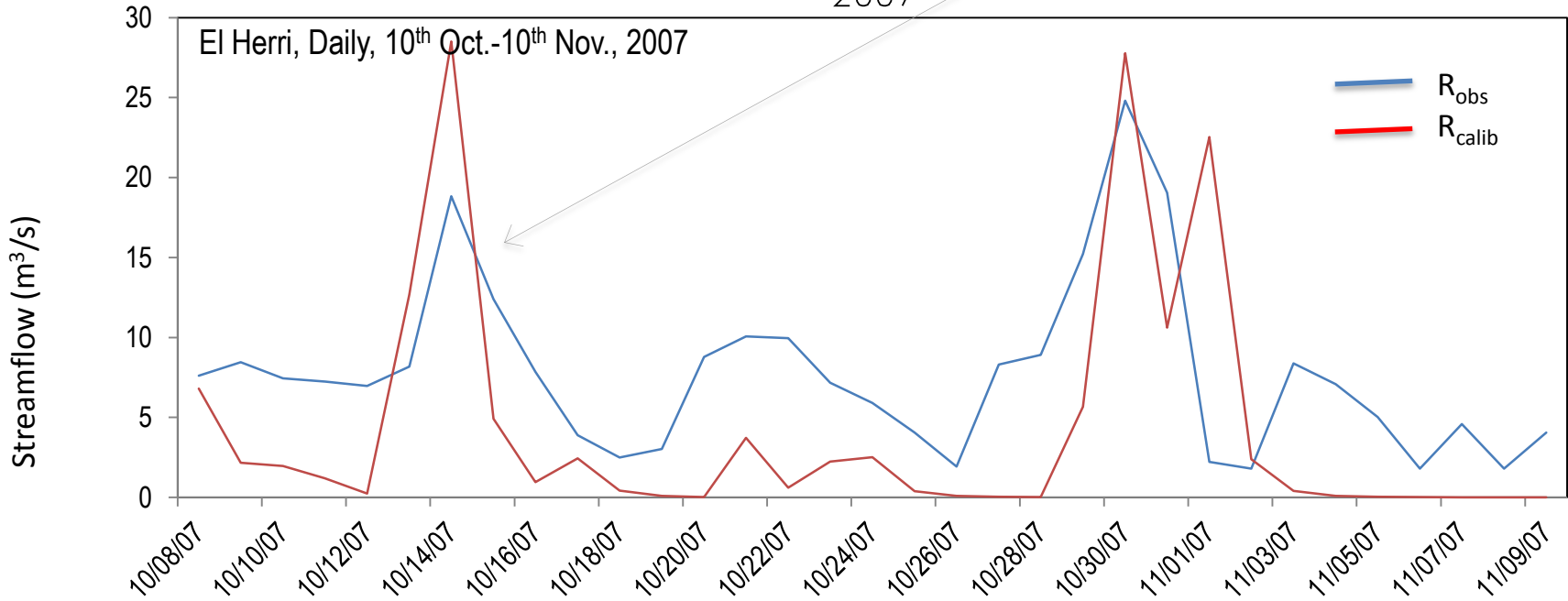


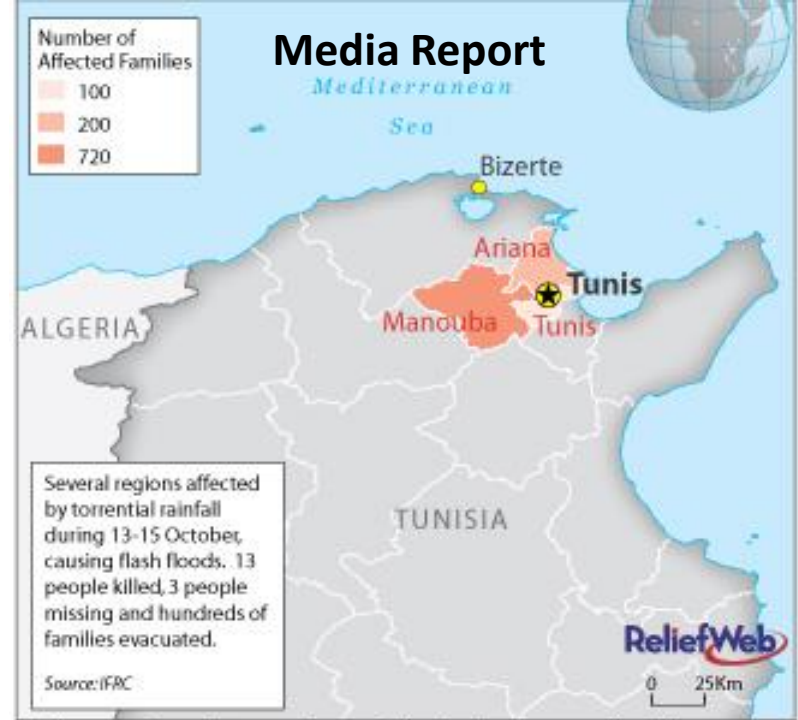
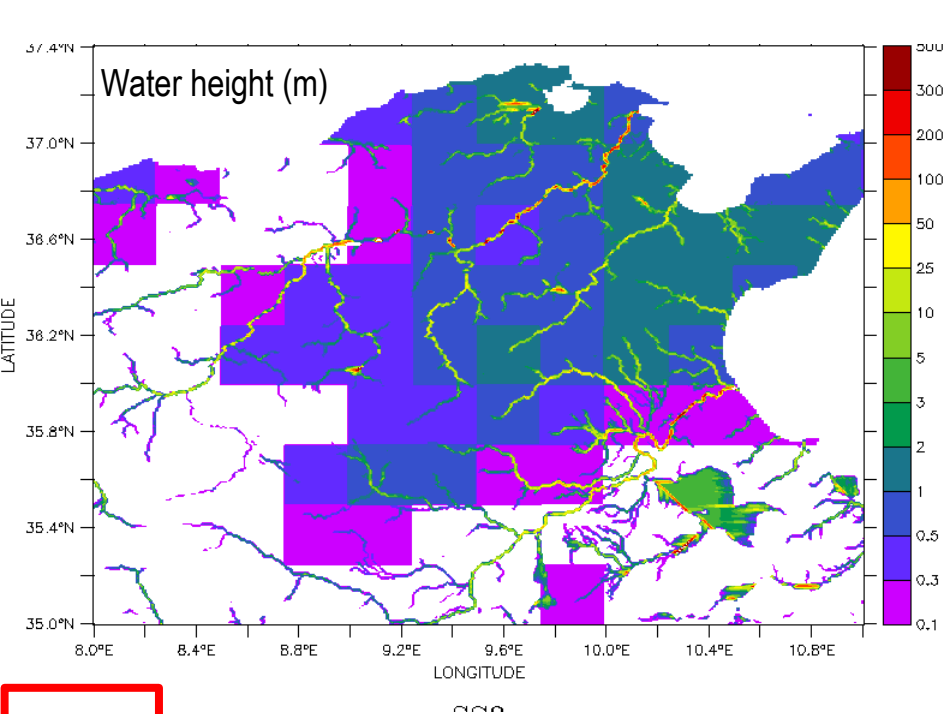
# CREST Calibration (1km) versus Stream-Gauge

El Herri, Monthly, 2007



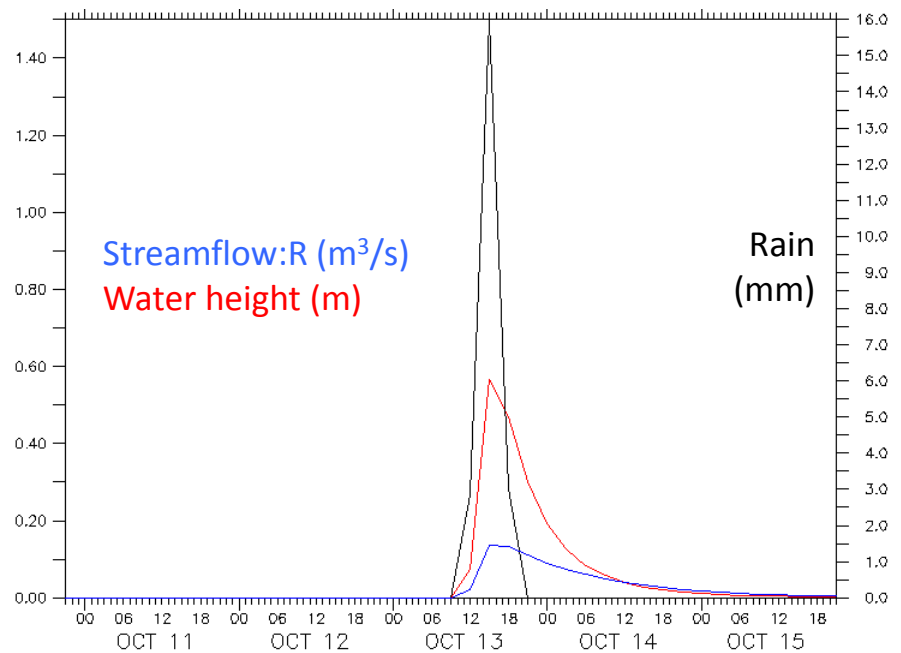
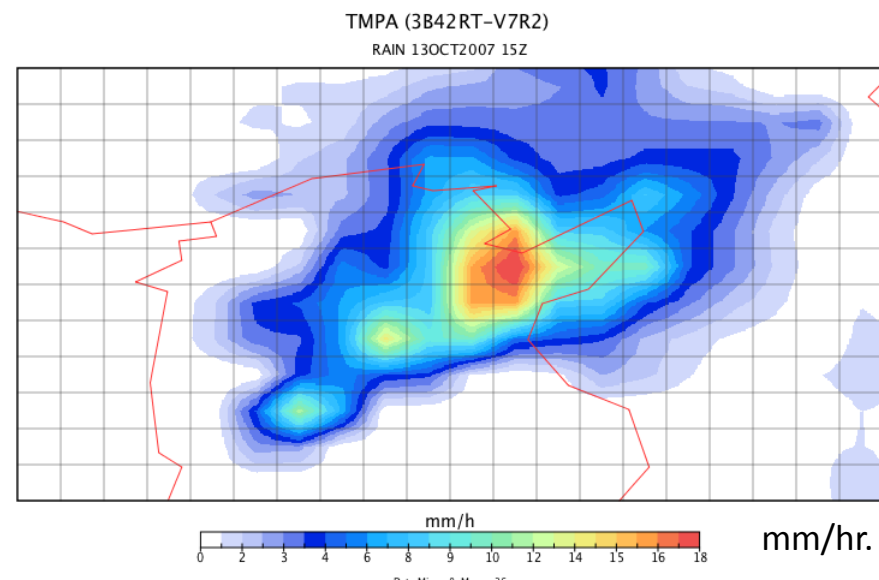
El Herri, Daily, 10<sup>th</sup> Oct.-10<sup>th</sup> Nov., 2007



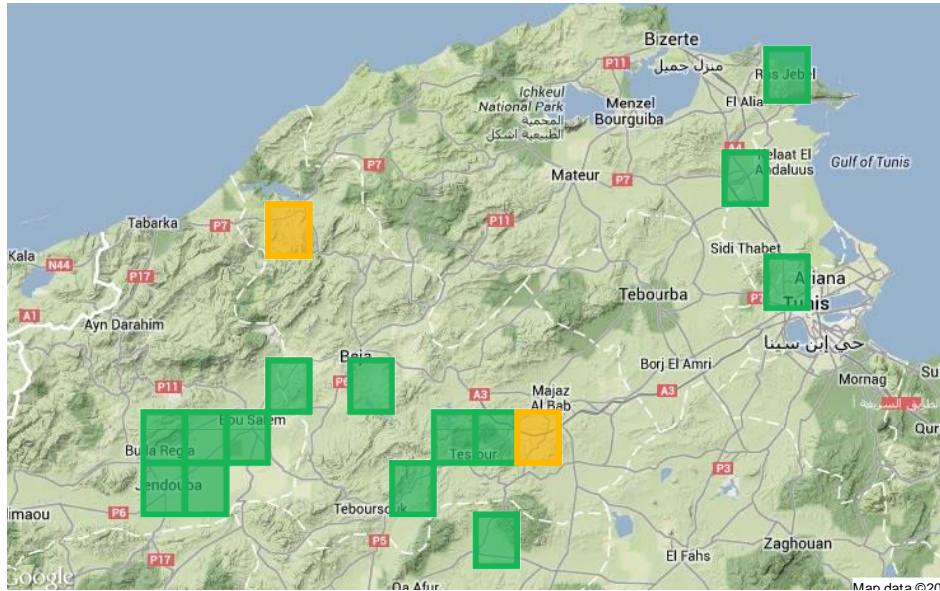


**CR07**

## CREST Simulation: 13-17 Oct. 2007, 15Z, Flood over Tunisia



## River Watch Locations, Tunisia



### Signal

$$M/C = BT_{\text{wet}}/BT_{\text{dry}}$$

Wet measurement pixel over River

Dry pixel not affected by flooding

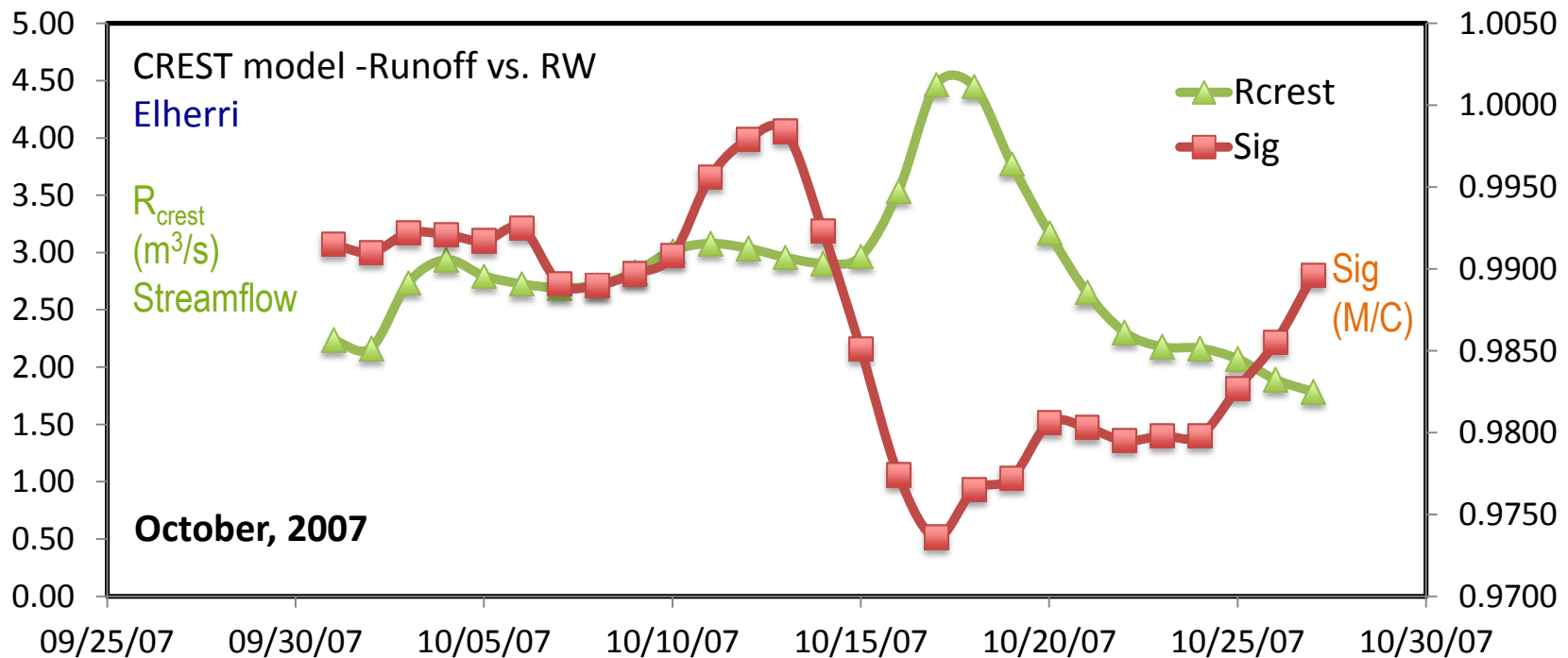
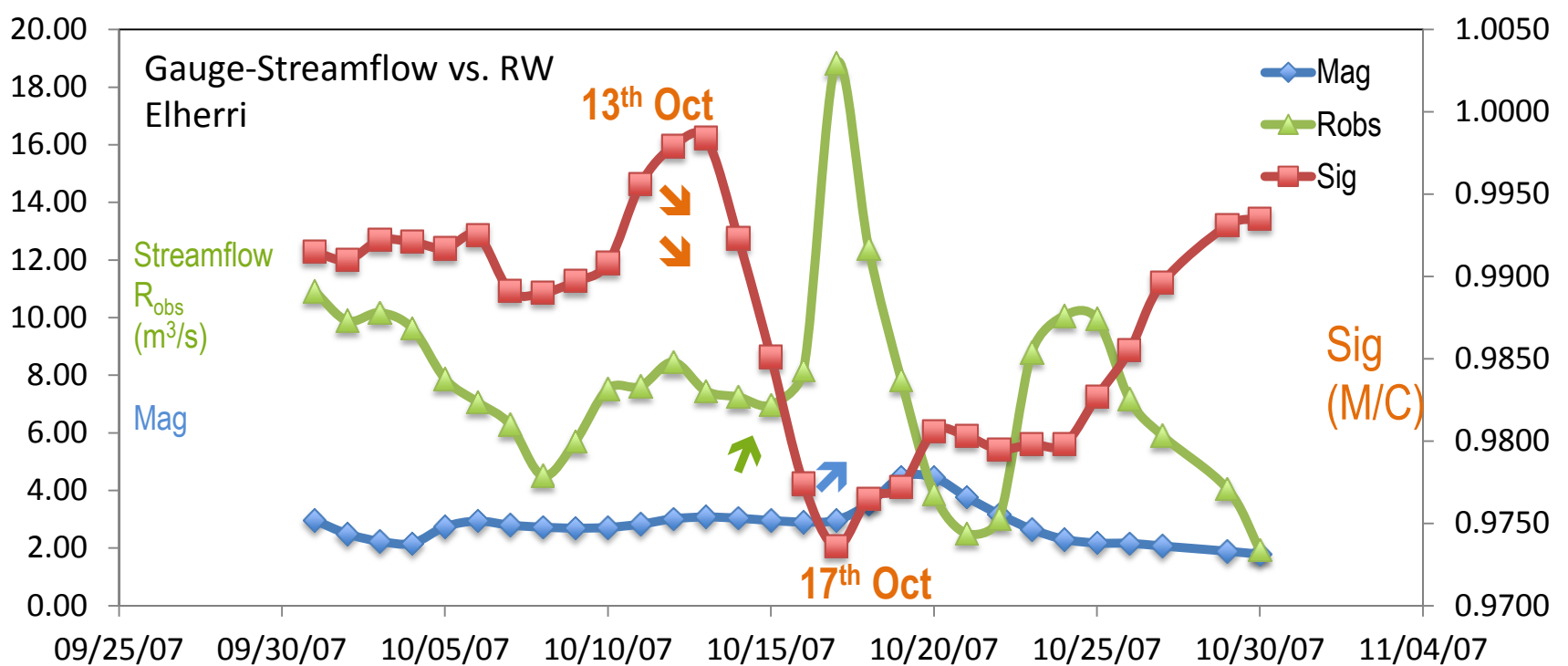
### Magnitude:

Signal anomaly

(SD removed from mean)

Courtesy: Global Flood Detection, JRC

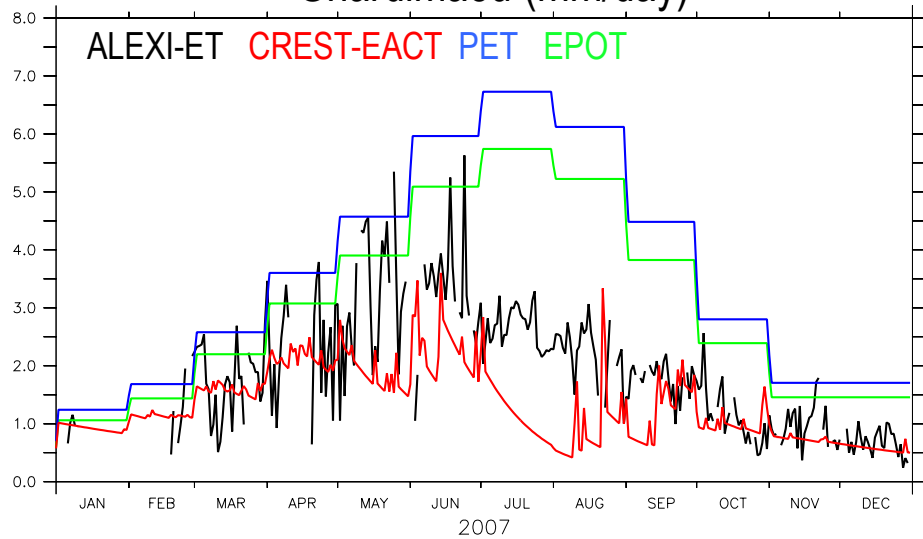
- Uses 36GHz H-polarization band (AMSRE on NASA EOS Aqua)
- Footprint size ~ 8x12km (level 2A)
- Assumption: Wet and Dry land surfaces have same characteristics except for water surface extent



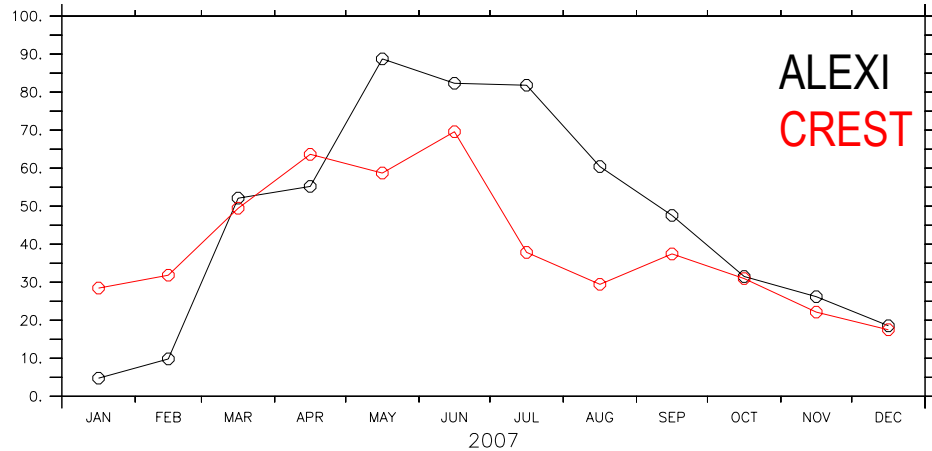
**CR09**

# Daily and monthly ET based on CREST and ALEXI-ET

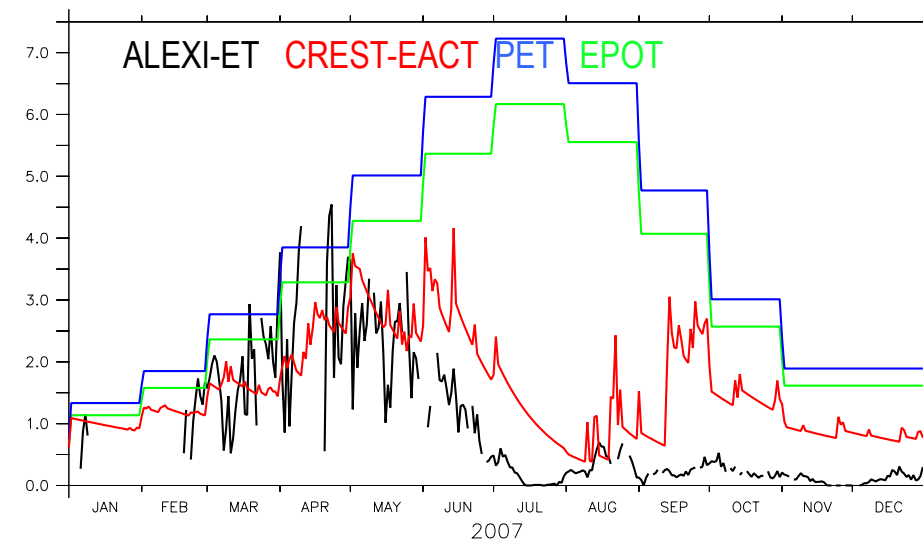
Ghardimaou (mm/day)



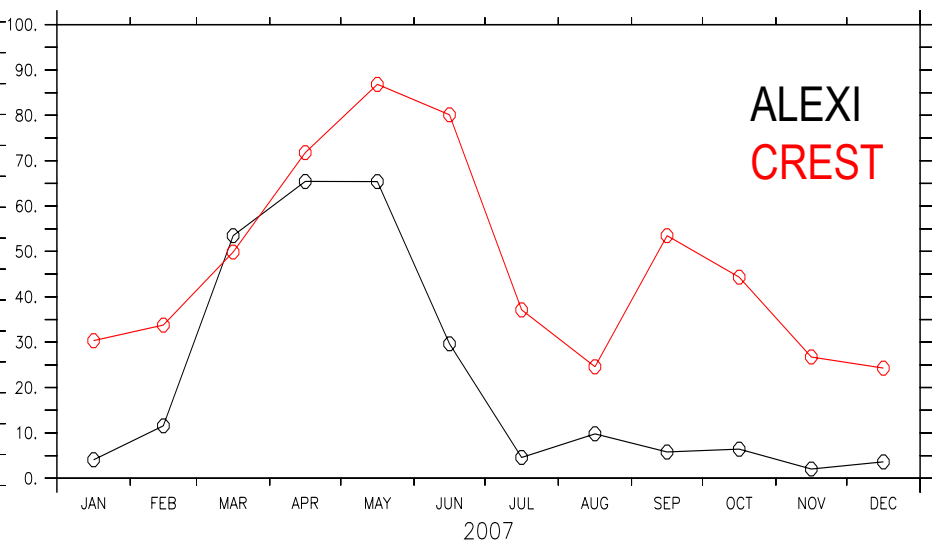
Ghardimaou (mm/month)



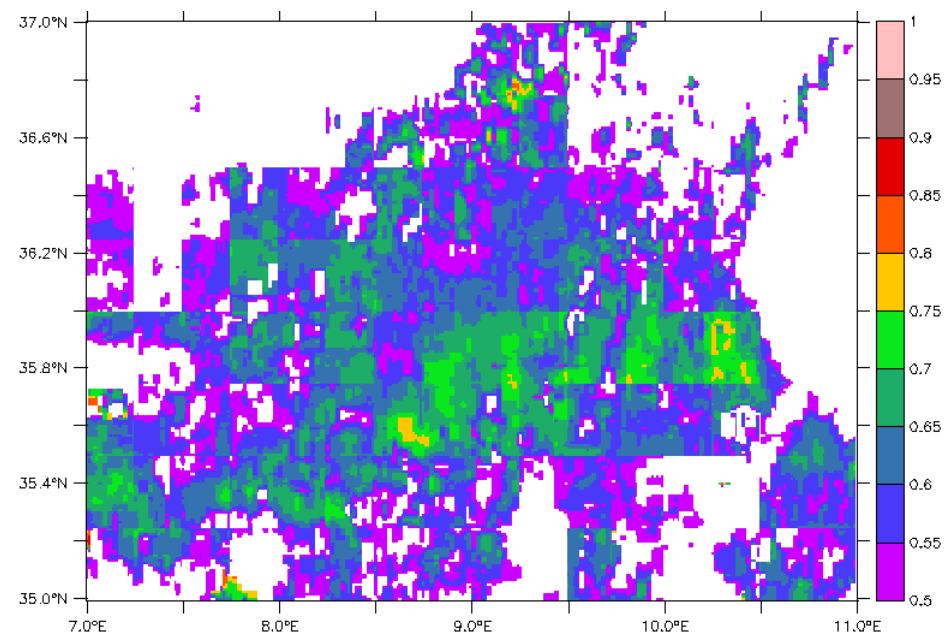
Sers Deligation (mm/day)



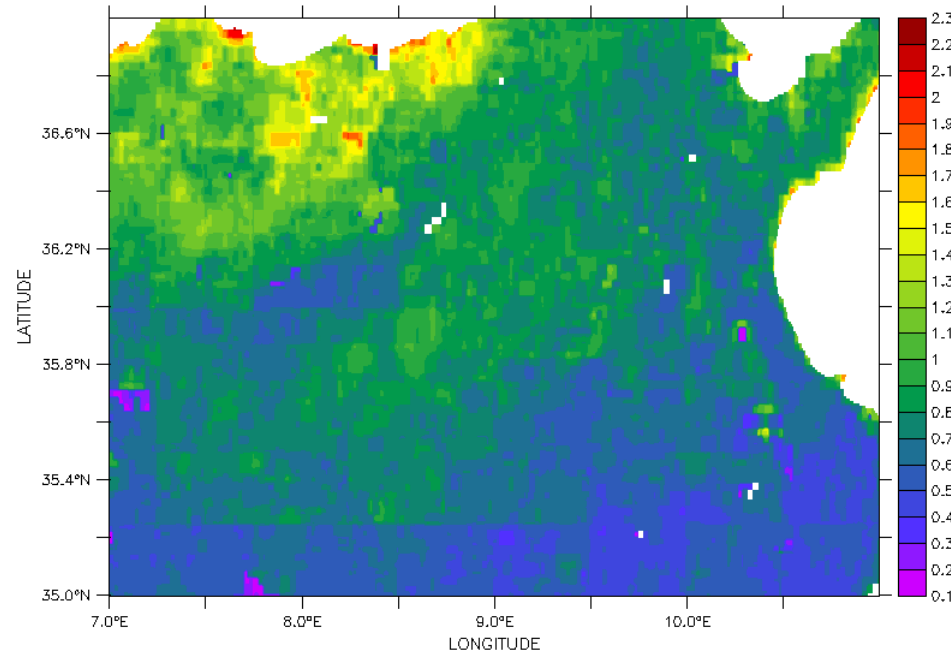
Sers Deligation (mm/month)



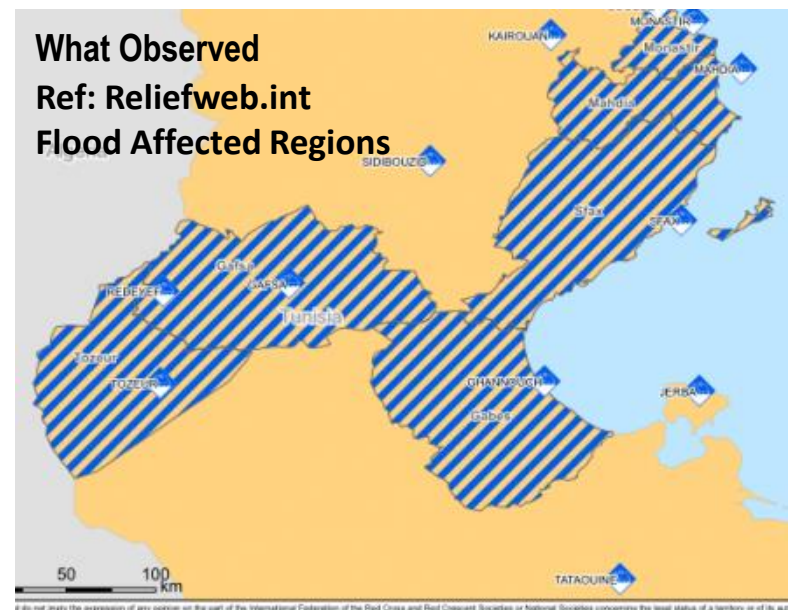
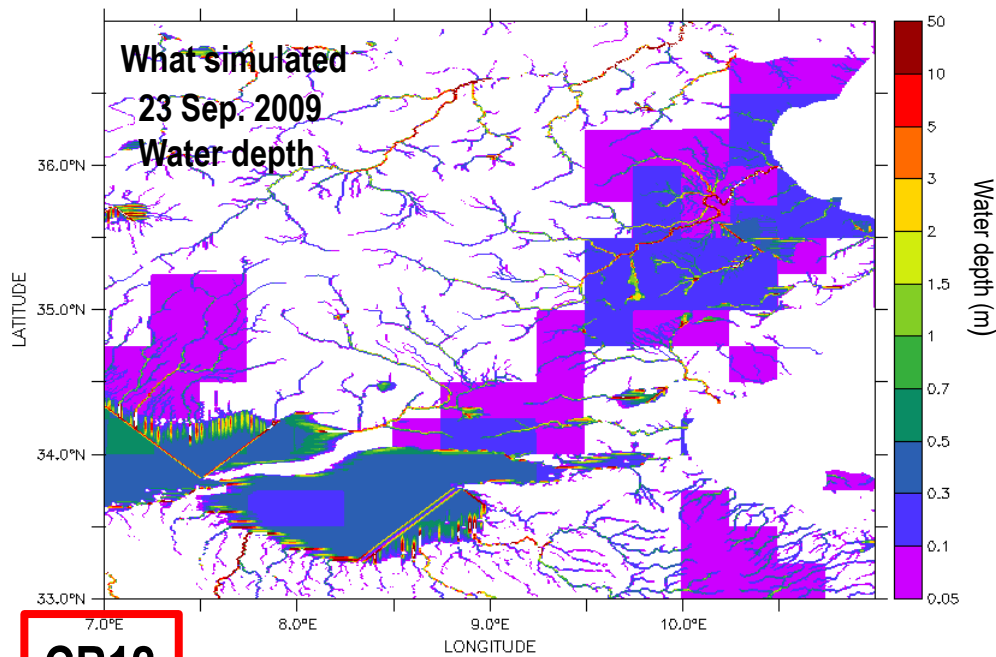
CREST-AET versus ALEXI-ET, Spatial Correlation, (plotted only  $r > 0.5$ ), 2007



*CREST AET versus ALEXI-ET RMS Errors, 2007*

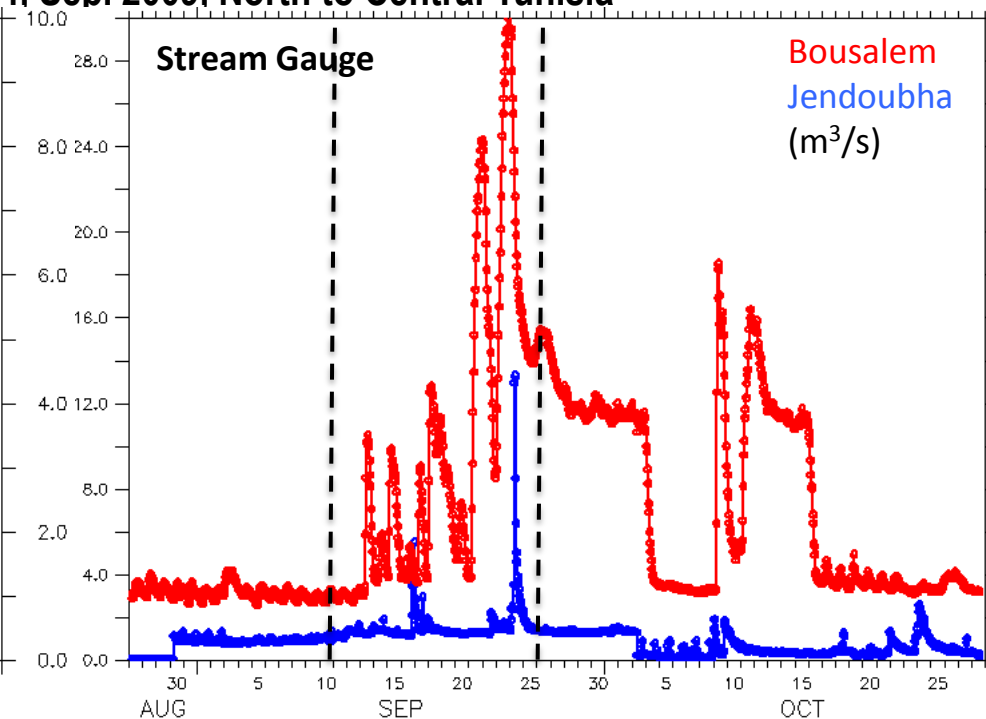
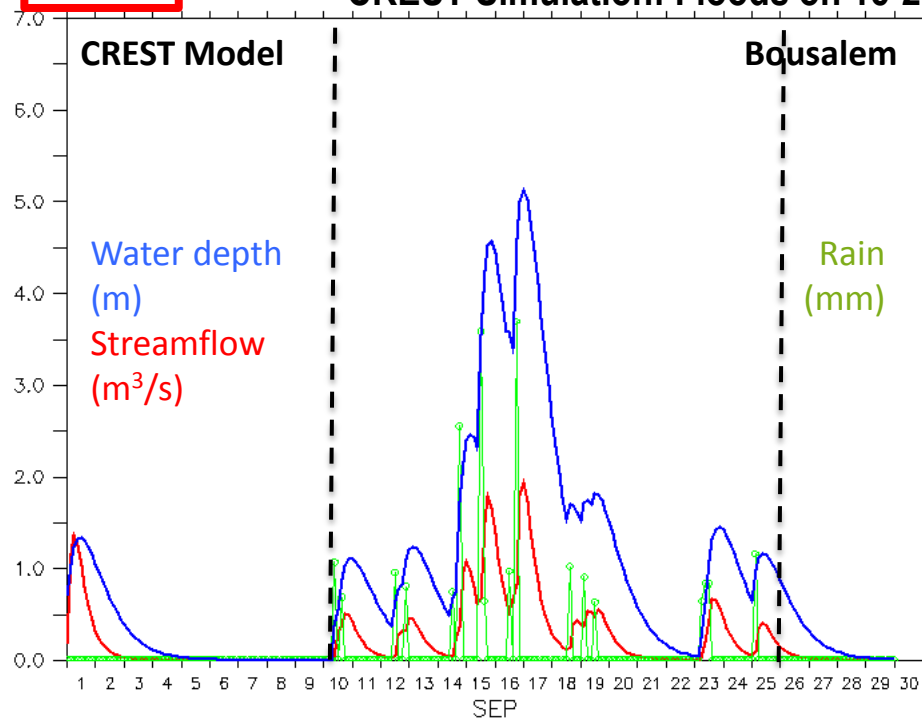


**Flood Case Study: September, 2012**  
**Evaluation: Beyond the Calibration period**

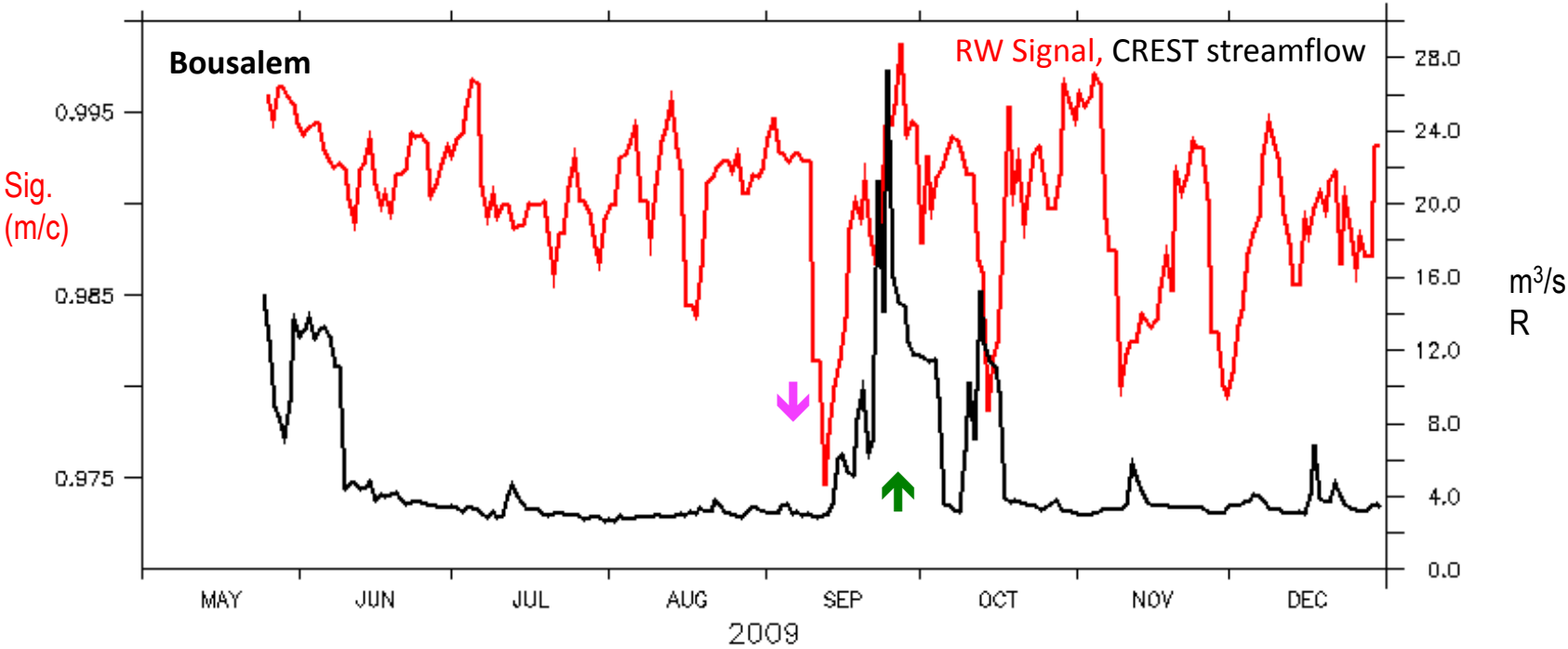


**CR12**

## CREST Simulation: Floods on 15-24, Sep. 2009, North to Central Tunisia



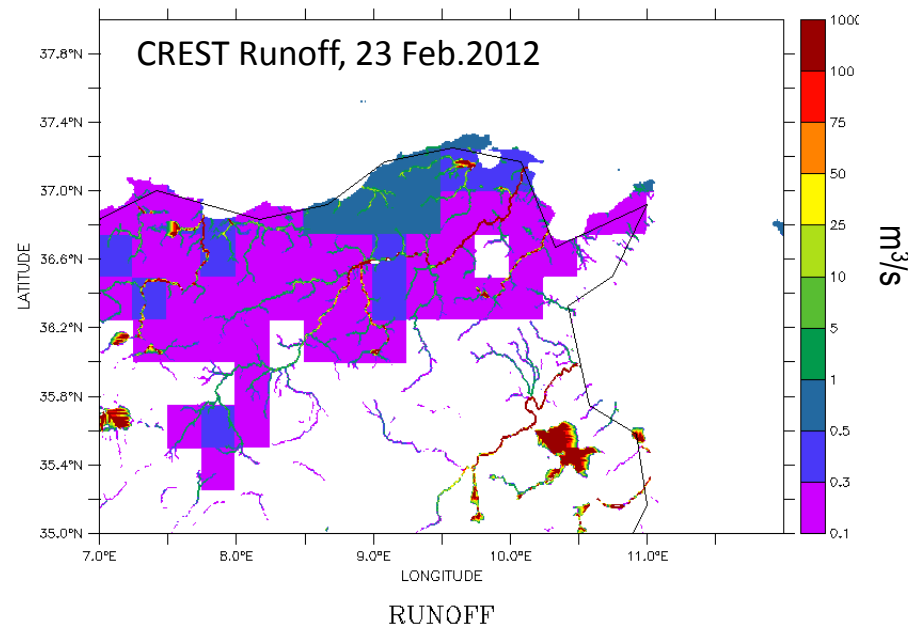
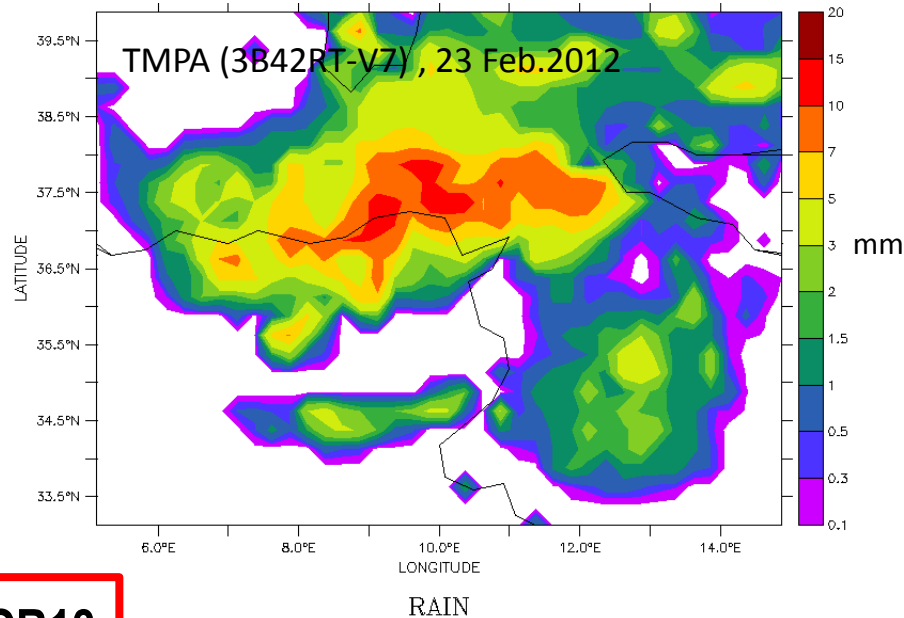
CREST versus River Watch



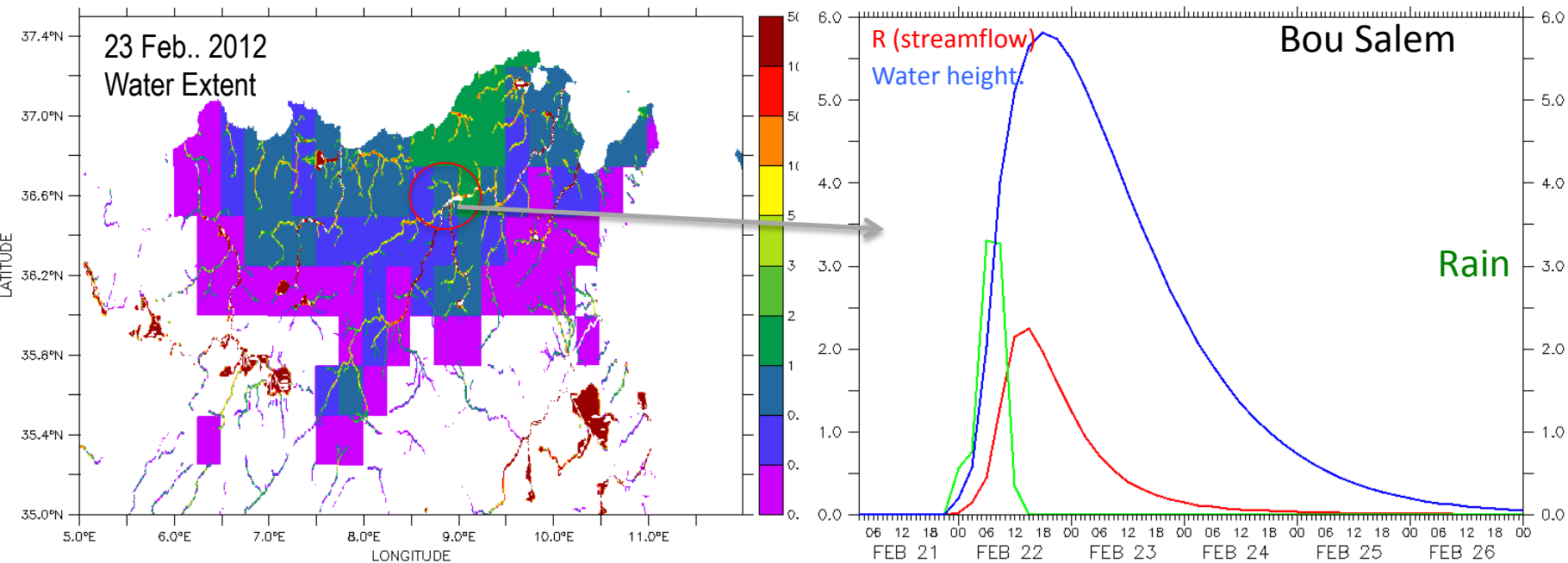
# **Flood Case Study: September, 2012**

## **Evaluation: Beyond Calibration period**

CR13

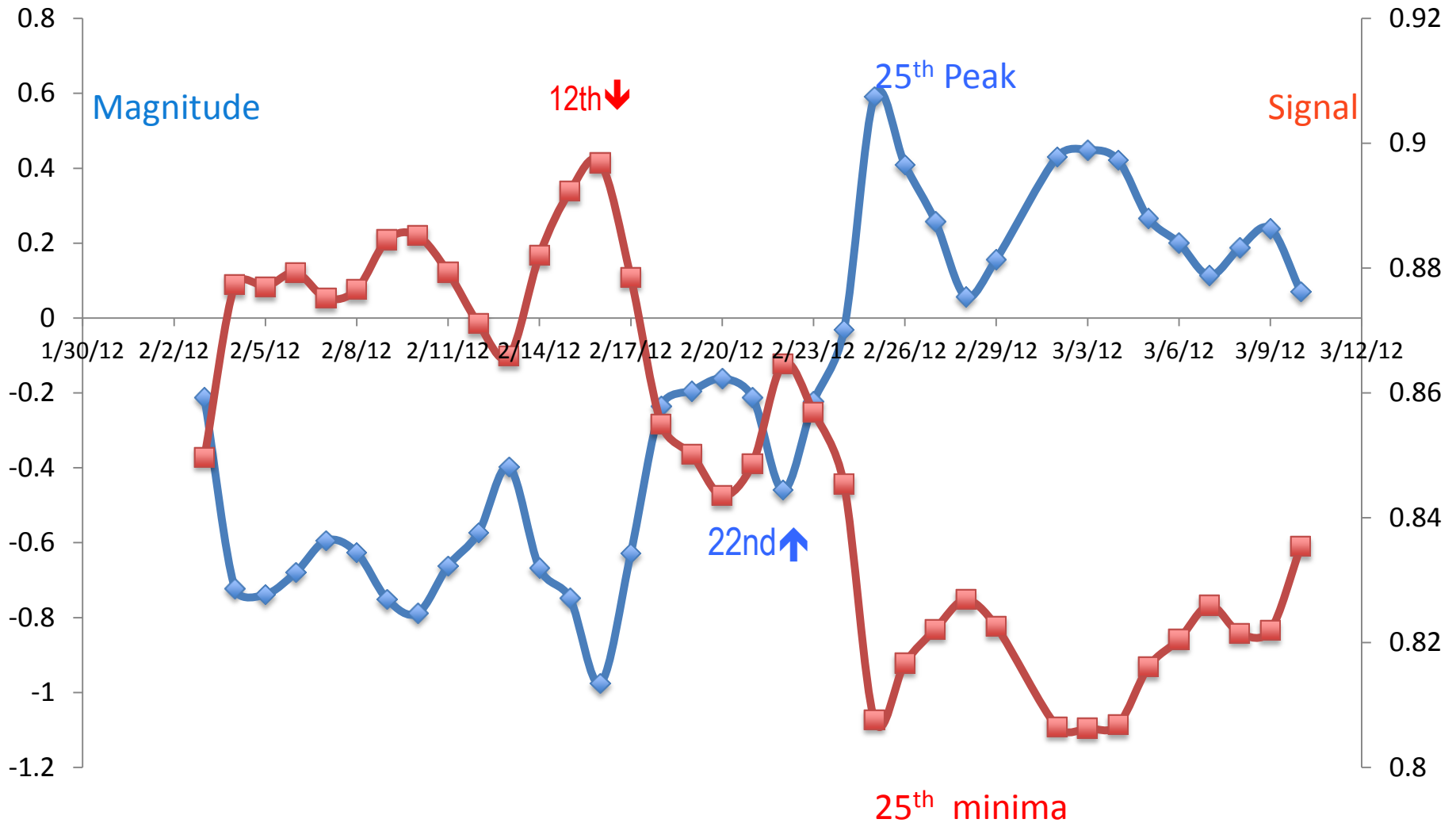


### CREST Model Simulations, 21-27 Feb. 2012 Flood



# River Watch Flood Signal

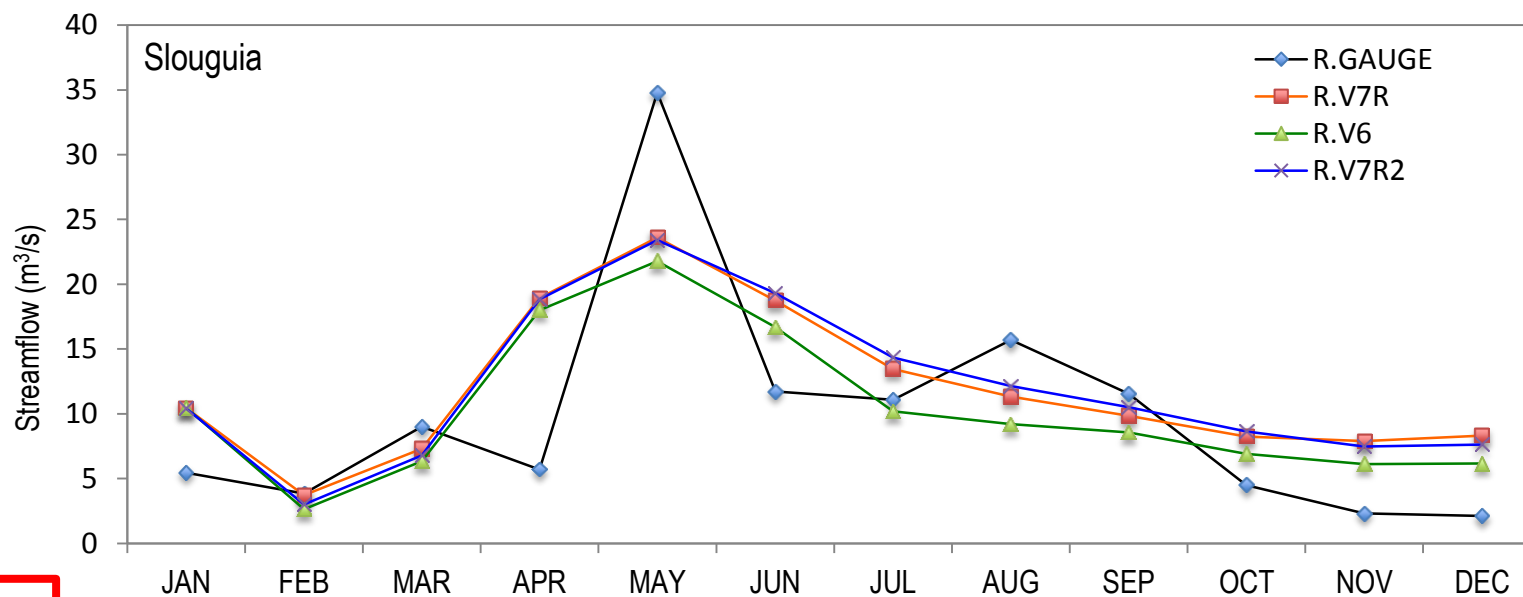
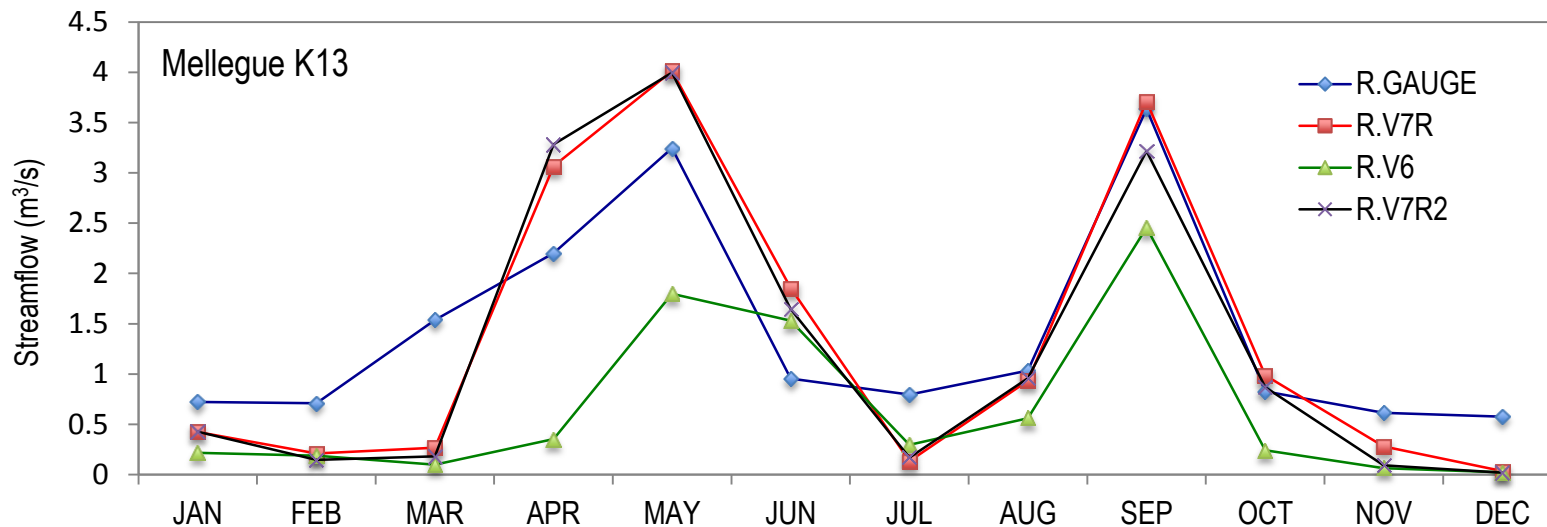
Station ID: 15187 RW, Feb. 2012



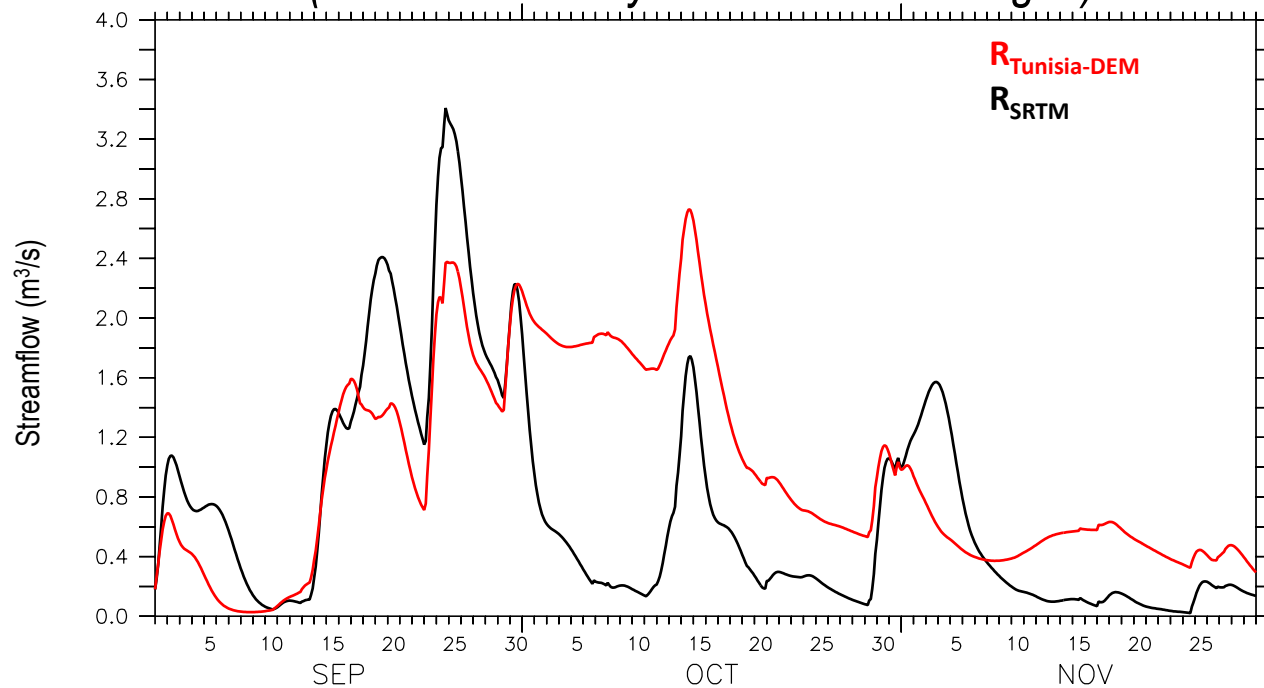
CR14

# **Model Sensitivity to Input Basics and Forcing data**

# CREST Streamflow (R) Sensitivity to TMPA versions, Tunisia, 2007



*CREST Streamflow (R) averaged for the Medjerda sub-domain (9.4E-9.6E, 36.5N-36.6N)*  
*(Model Sensitivity to DEM/FAC changes)*



*Note:  $R_{Tunisia-DEM}$  is based on model run with same parameters as used in  $R_{SRTM}$*